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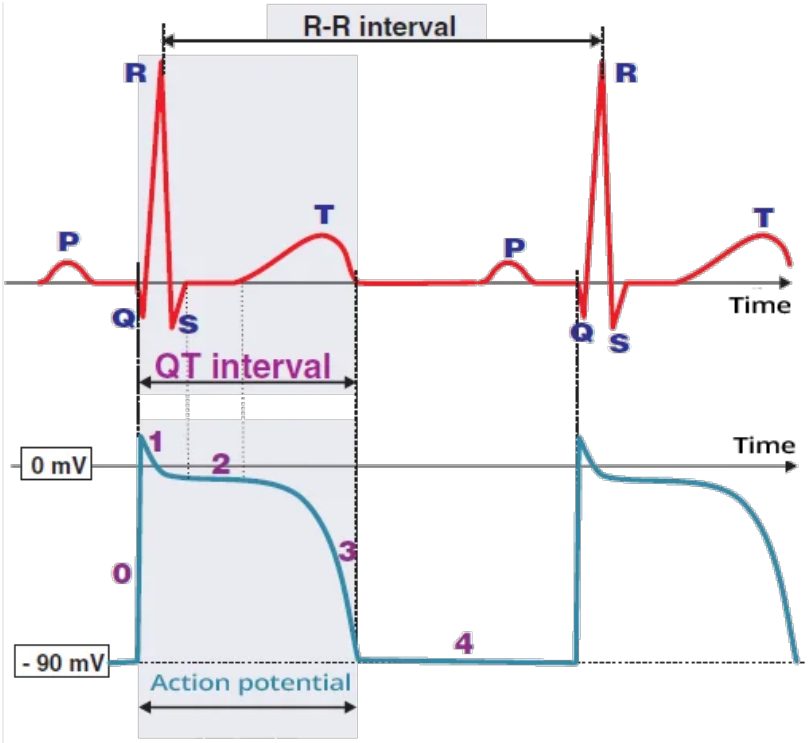
Phase 3 Block (Tachycardia-Dependent Block) - ECG

Phase 3 aberracy, Phase 3 block, Tachycardia-dependent block, Rate-dependent bundle branch block

- Phase 3 of the Action Potential
- Action Potential and Refractory Period
- Block in Phase 3
- ECG and Block in Phase 3
- Atrial Extrasystole and Block in Phase 3
- Tachycardia-Dependent Blockade

Phase 3 of the Action Potential

- Action potential (impulse) is a **rapid change in the electrical voltage of cardiomyocytes**
  - It occurs due to the change in the concentration of intracellular and extracellular ions
- **The action potential propagates**
  - **Rapidly** through the conduction system
  - **Slowly** through the working myocardium



Phase 3 of the Action Potential

- On the **ECG**, it appears as the T wave (ventricular repolarization)
- It is the **relative refractory period (RRP)**
  - If an impulse arrives at a cardiomyocyte (in the conduction system or myocardium) **during the RRP**
  - This **impulse will be blocked**

Action Potential and Refractory Period

- **ARP** (Absolute Refractory Period)
  - During ARP, **cardiomyocytes do not respond to another impulse**
- **RRP** (Relative Refractory Period)
  - During RRP, **cardiomyocytes respond only to a suprathreshold impulse**

- For example, if the **right bundle branch is in ARP**
  - And a **supraventricular impulse** arrives at the branch **during ARP**
    - from an atrial extrasystole
  - This **impulse will be blocked in the branch**
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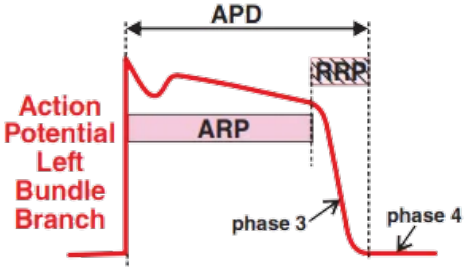

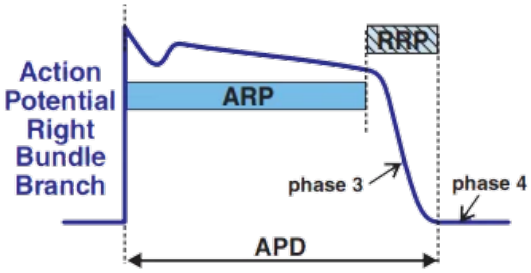

- **Left bundle branch**
  - has a **short ARP** (Absolute Refractory Period)

- **Right bundle branch**
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Block in Phase 3

- A block occurs when a supraventricular impulse **arrives** at **some part** of the ventricular conduction system
  - in the **3rd phase of the action potential** (Relative Refractory Period)
  - This supraventricular impulse is **blocked** in the affected part of the conduction system

- It is the **most common cause** of aberrant conduction
  - It is a temporary disorder of the **ventricular** conduction system
  - It is an **abnormal conduction of the impulse** (action potential) through the **ventricular conduction system**
    - It is a **physiological response** of the conduction system **to overload**

- **On an ECG, it may appear as**
  - Right Bundle Branch Block (RBBB)
    - This is the **most common block pattern in Phase 3**
    - Because the **right bundle branch has a longer refractory period** than the left
  - Left Bundle Branch Block (LBBB)
  - Complete AV Block
  - Fascicular Block (anterior or posterior)

- **Phase 3 block** creates a **tachycardia-dependent block** during supraventricular tachycardias

- **Ashman Phenomenon**
  - The Ashman Phenomenon is a Phase 3 block that occurs **after a prolonged** RR interval
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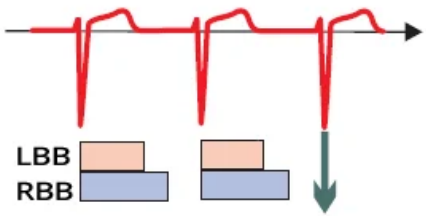
ECG and Block in Phase 3

- The Right Bundle Branch (**RBB**) has a **longer** Absolute Refractory Period **(ARP)**
  - than the Left Bundle Branch (**LBB**)



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- Supraventricular impulse
  - Passes through the branches
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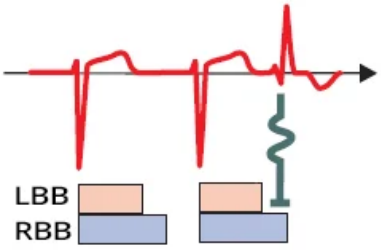
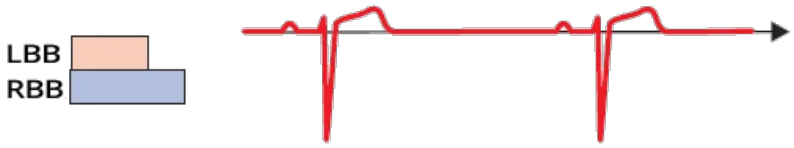


Aberrant Conduction

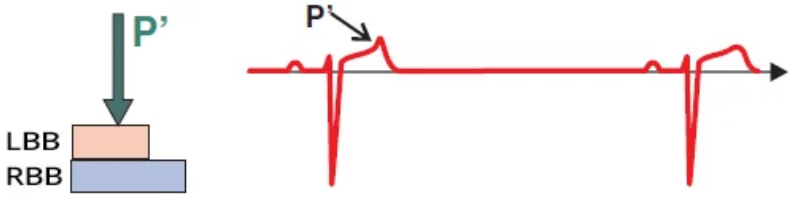
- Supraventricular extrasystole
  - Occurred during the **RRP of the right bundle branch**
- **The extrasystole is blocked only in the right bundle branch**
  - QRS is wide and has the shape of a right bundle branch block
    - The impulse is conducted only by the left bundle branch

Atrial Extrasystole and Block in Phase 3



Sinus Rhythm

- Sinus rhythm **without** atrial extrasystole
- Every P wave is conducted through the bundle branches

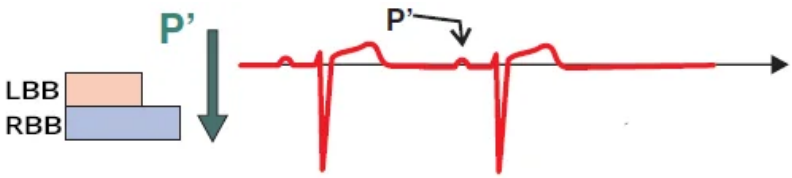


Atrial Extrasystole (Blocked)

- Conducts to the ventricles **during the T wave** (both bundle branches are in phase 3 - **RRP**)
- It is **completely blocked** in the bundle branches
- If atrial tachycardia arose and P waves occurred during the RRP of the bundle branches
  - All P waves would be **blocked**, resulting in a functional third-degree AV block (complete AV block) on the ECG

Atrial Extrasystole (with RBBB Pattern)

- Extrasystole conducts to the ventricles **during the RRP (phase 3) of the right bundle branch**
- It is **blocked in the right bundle branch**
- On the **ECG**, a pattern of right bundle branch block (RBBB) is observed
- This is a case of aberrant conduction of the atrial extrasystole



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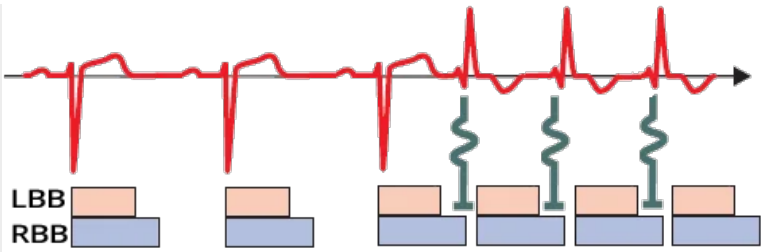
- Extrasystole conducts to the ventricles **outside the RRP (phase 3)** of the bundle branches
- It is not blocked
- A **premature QRS complex** occurs (which has the same shape as the sinus QRS)

Tachycardia-Dependent Blockade

- **Block in phase 3** is most commonly seen in supraventricular tachycardias (SVT)
  - During SVT, **impulses begin to pass through the bundle branches during the RRP** (in phase 3)
  - This is a **functional block of the conduction system**
    - The block is most often in the **right bundle branch** (due to the longest refractory period)
- **The block is present only during tachycardia**
  - When tachycardia subsides, the **functional block disappears**



Functional Bundle Branch Block and Supraventricular Tachycardia

- Initially, there is sinus rhythm
- Then a paroxysm of SVT follows
  - Supraventricular **impulses** pass through the ventricular system during the **RRP of the right bundle branch**
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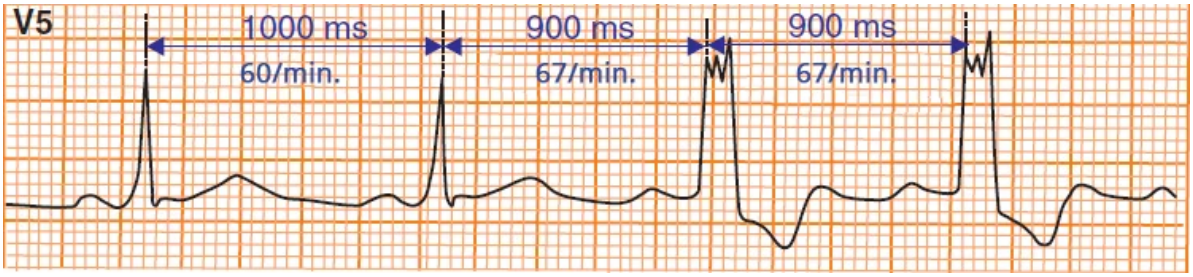
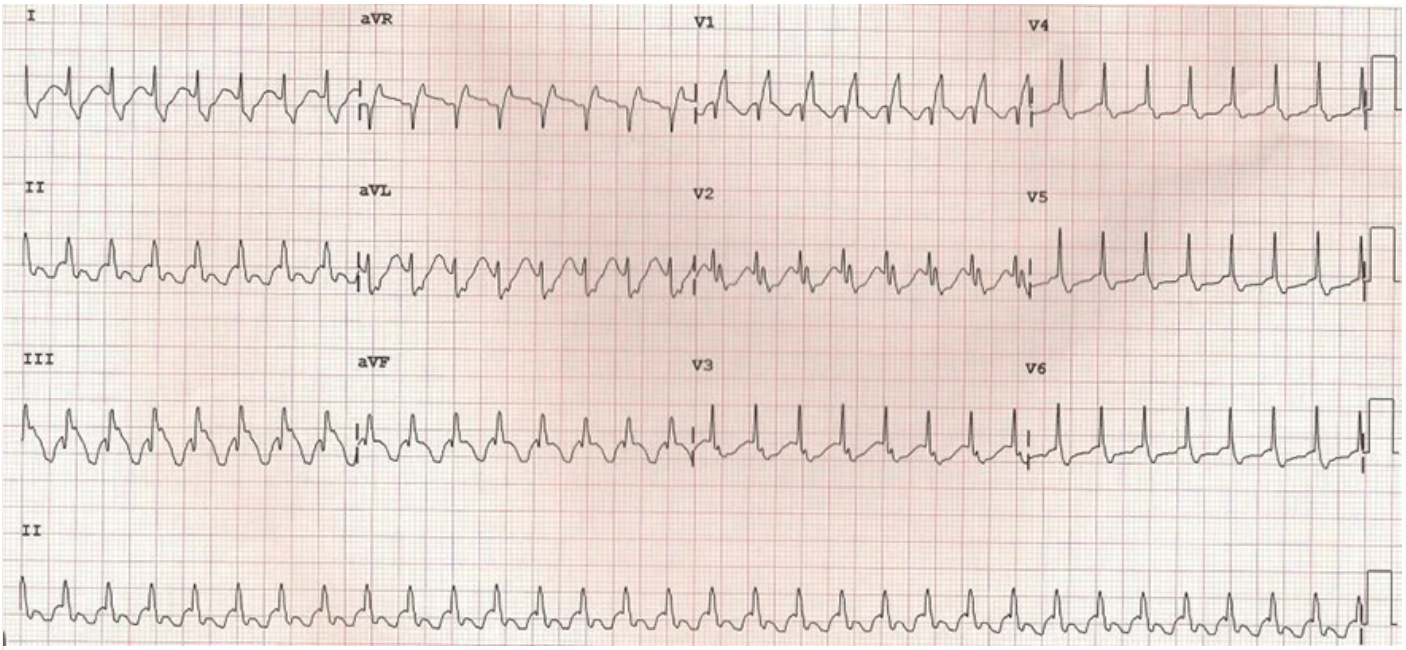


Functional Left Bundle Branch Block (block in phase 3)

- This is sinus rhythm with a frequency of **60/min.**
- When the frequency rises to **67/min.**
  - A left bundle branch block (LBBB) **occurs**
- This is a **tachycardia-dependent block** (even though a frequency of 67/min. is not considered tachycardia)
- If a **functional bundle branch block occurs at a frequency below 100/min.**
  - It indicates **damage** to the conduction system, such as in cardiomyopathy
  - The left bundle branch is more damaged in this case than the right



Functional Right Bundle Branch Block (block in phase 3)

- With sinus rhythm at a **rate of 80/min.**
  - The patient **did not have a bundle branch block**
  - **Later experienced palpitations,** and the recorded EKG showed **the mentioned block**
- It is paroxysmal SVT with a rate of **180/min.**
  - Not ventricular tachycardia (V1 shows rsR' - larger right rabbit ear)
- With an increase in **rate to 180/min.** a **right bundle branch block** appeared
  - Because supraventricular **impulses reach the right bundle in phase 3** of the action potential
  - This is a **tachycardia-dependent block**
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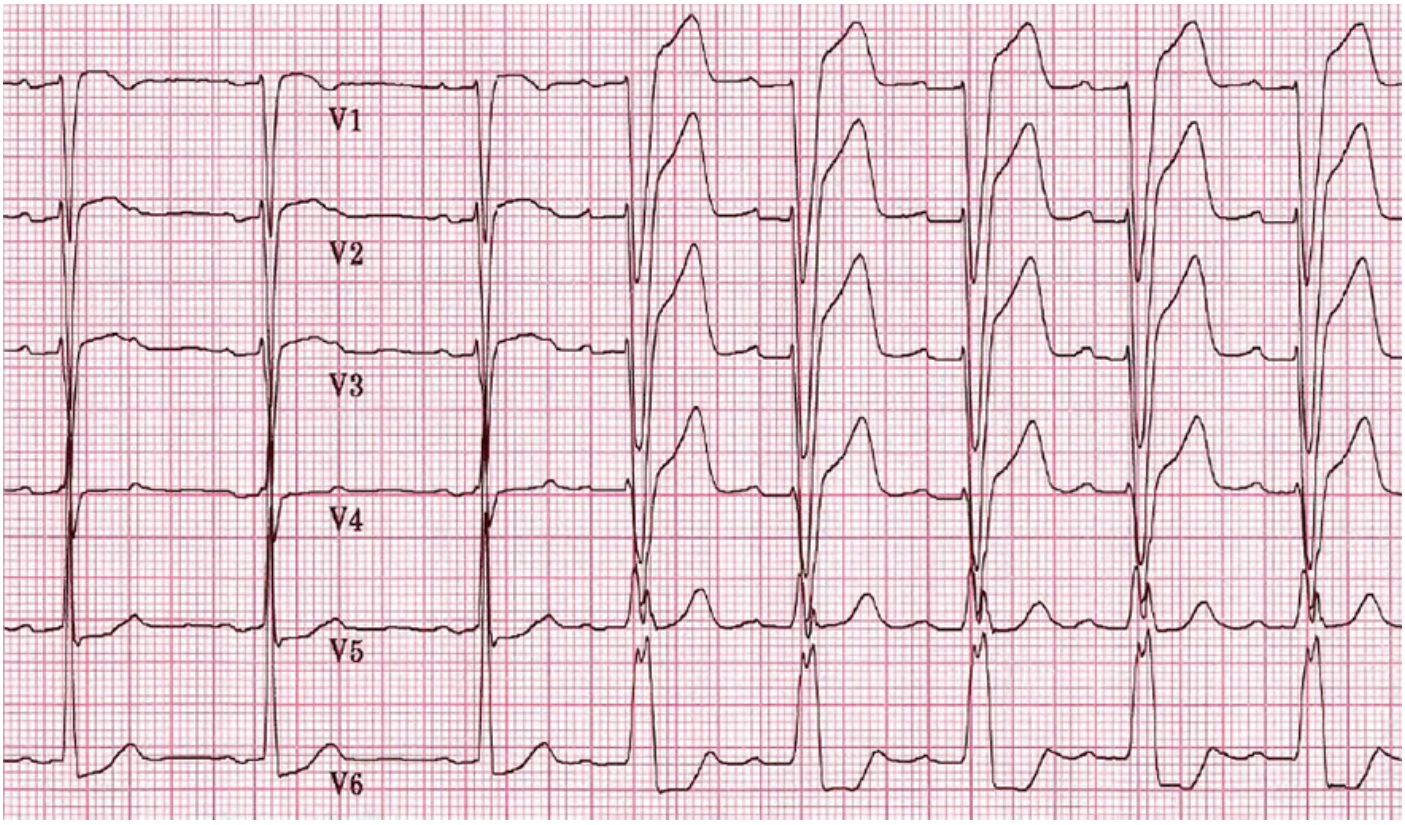

Functional Left Bundle Branch Block (block in phase 3)

- **The first 3 beats** are sinus beats with a rate of **60/min.**
- Then there was an increase in **rate to 75/min.**
  - And a left bundle branch block developed
- This is a **tachycardia-dependent block** (even though a rate of 75/min is not considered tachycardia)
  - Which occurred with the increase in rate
  - The left bundle **blocks impulses in phase 3**
- If a **functional bundle branch block develops at a rate below 100/min.**
  - It indicates **damage** to the conduction system, such as in cardiomyopathy
  - In this case, the left bundle branch is more damaged than the right

Functional Block of the Left Bundle Branch (Phase 3 Block)

- This is a sinus rhythm with a frequency of **70/min.**
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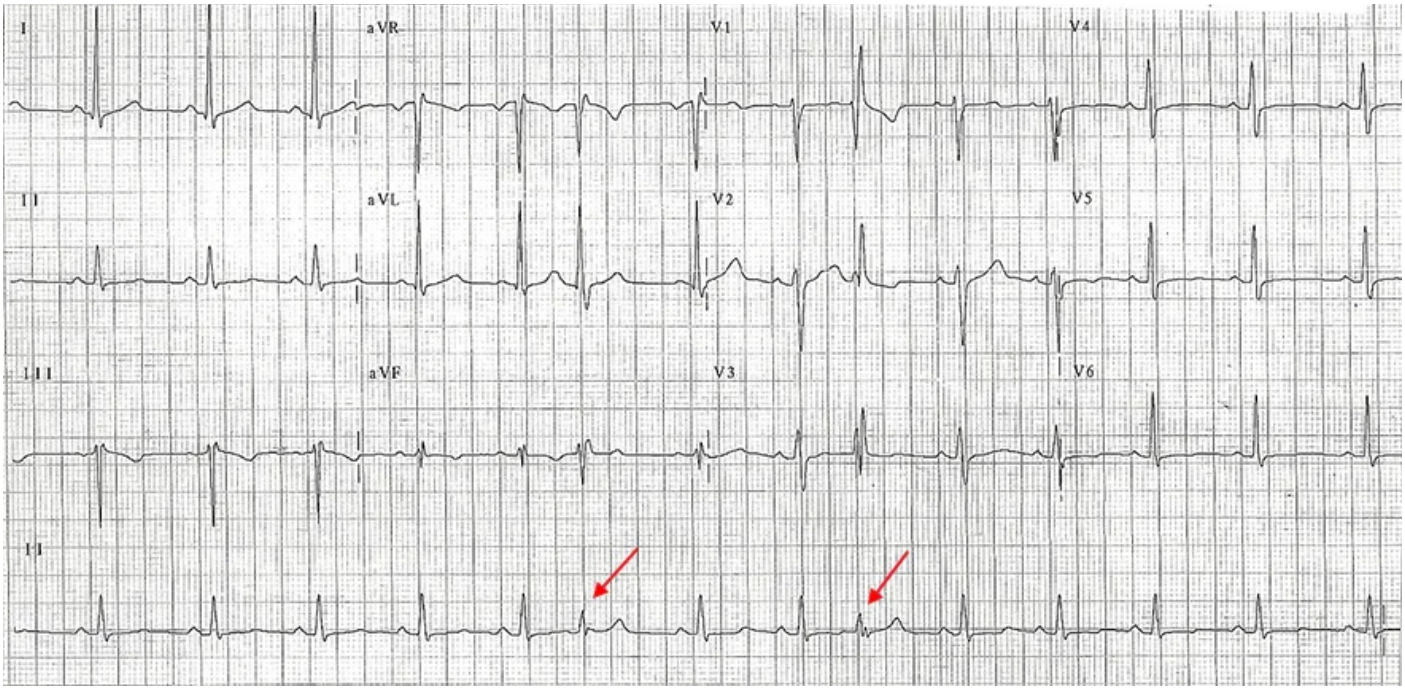

Aberrant Conduction and Sinus Rhythm

- Sinus rhythm
  - Heart rate: **75/min.**
- Continuous lead II (lowest)
  - The **6th and 9th QRS complexes** originated from an atrial extrasystole
    - In other leads, the QRS has the morphology of a right bundle branch block
- **Atrial extrasystoles**
  - Pass through the right bundle branch during **RRP (phase 3)**
  - Therefore, they are **blocked in the right bundle branch**, and the ventricles are activated **only through the left bundle branch**
  - This is an example of **aberrant conduction** (abnormal conduction of the impulse through the ventricular conduction system)

Sources

- ECG from Basics to Essentials Step by Step
- litfl.com
- ecgwaves.com
- metealpaslan.com
- medmastery.com
- uptodate.com
- ecgpedia.org
- wikipedia.org
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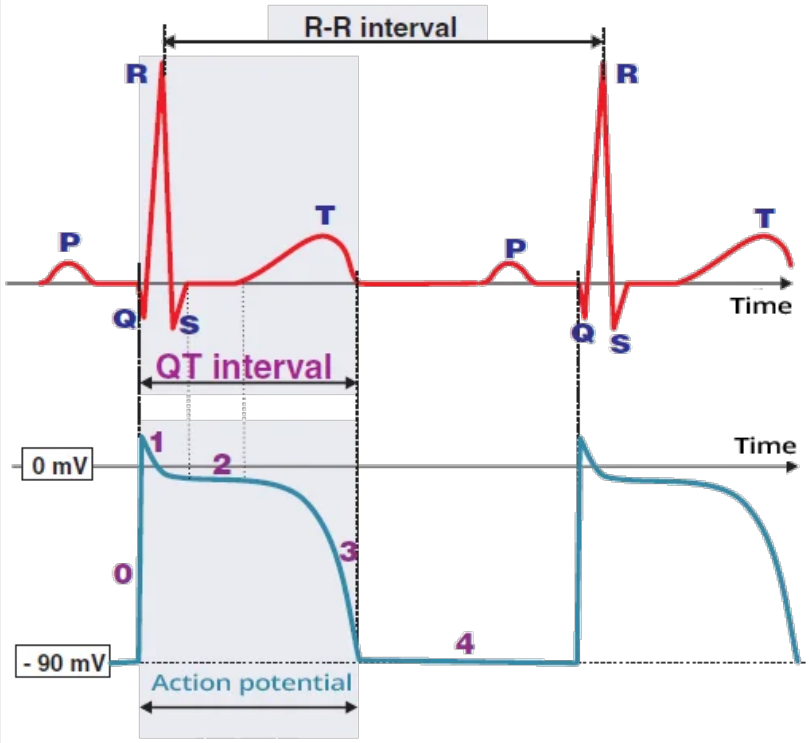

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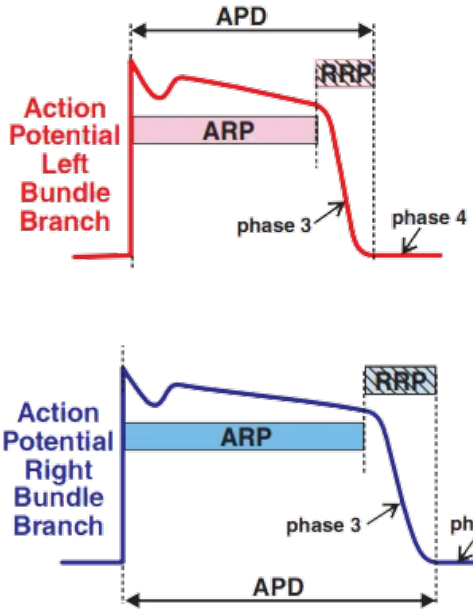

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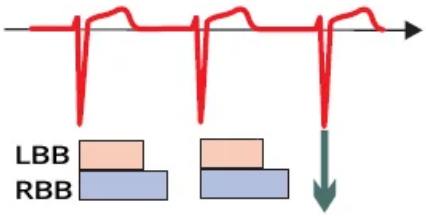

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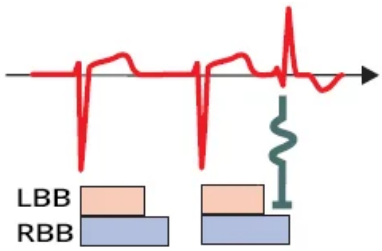

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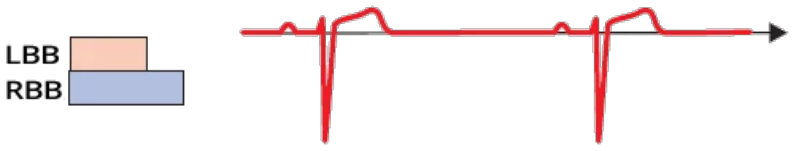

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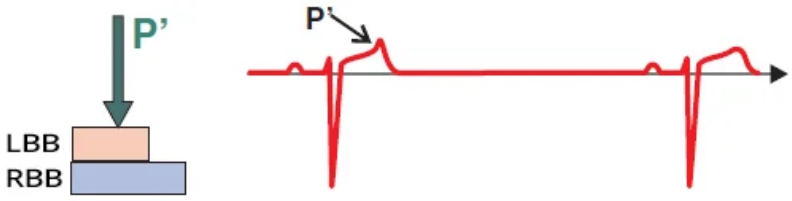

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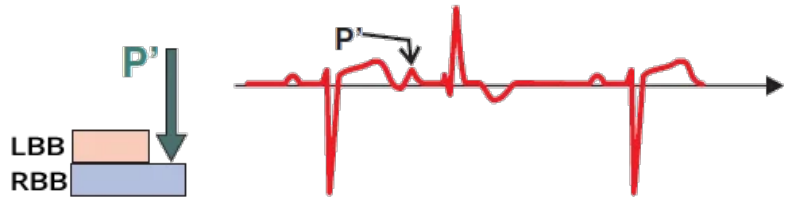

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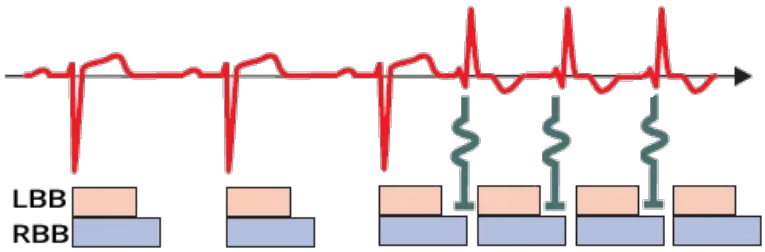

Functional Bundle Branch Block and Supraventricular Tachycardia

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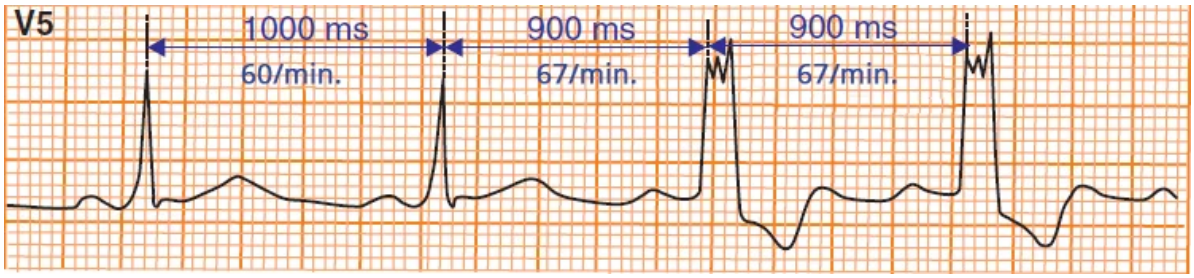

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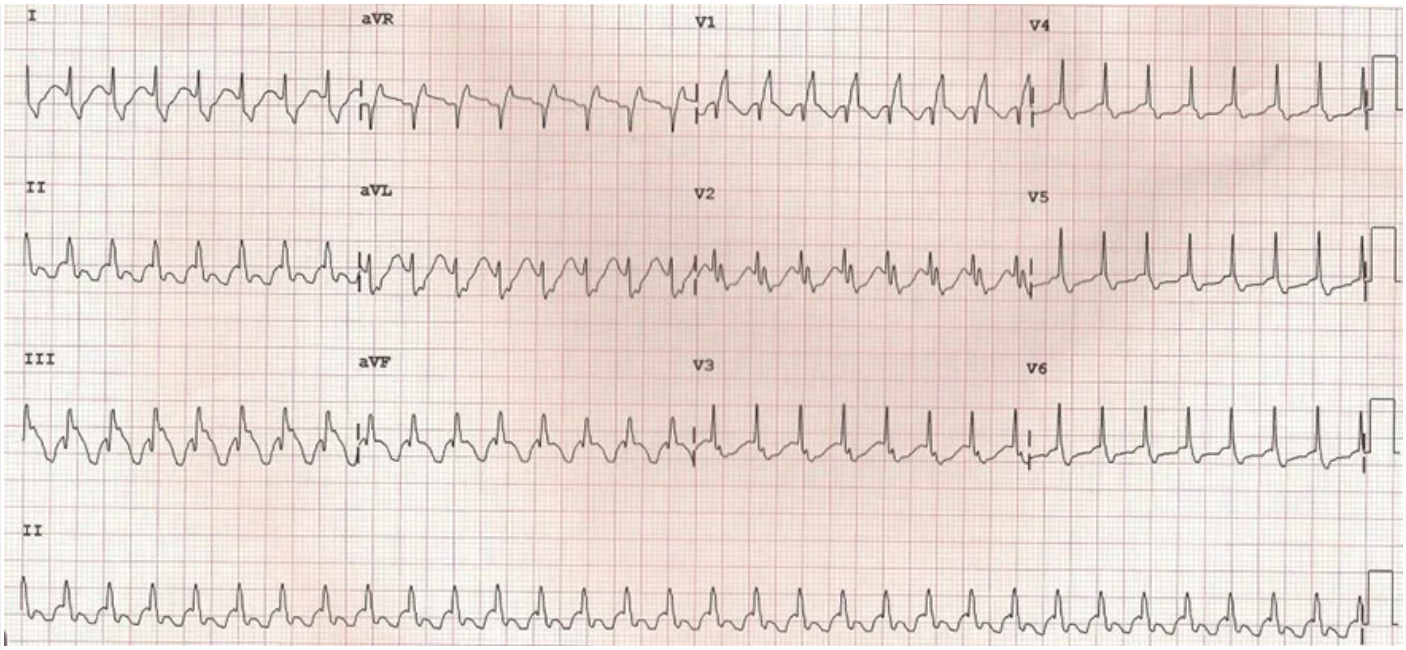

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- It is paroxysmal SVT with a rate of **180/min.**
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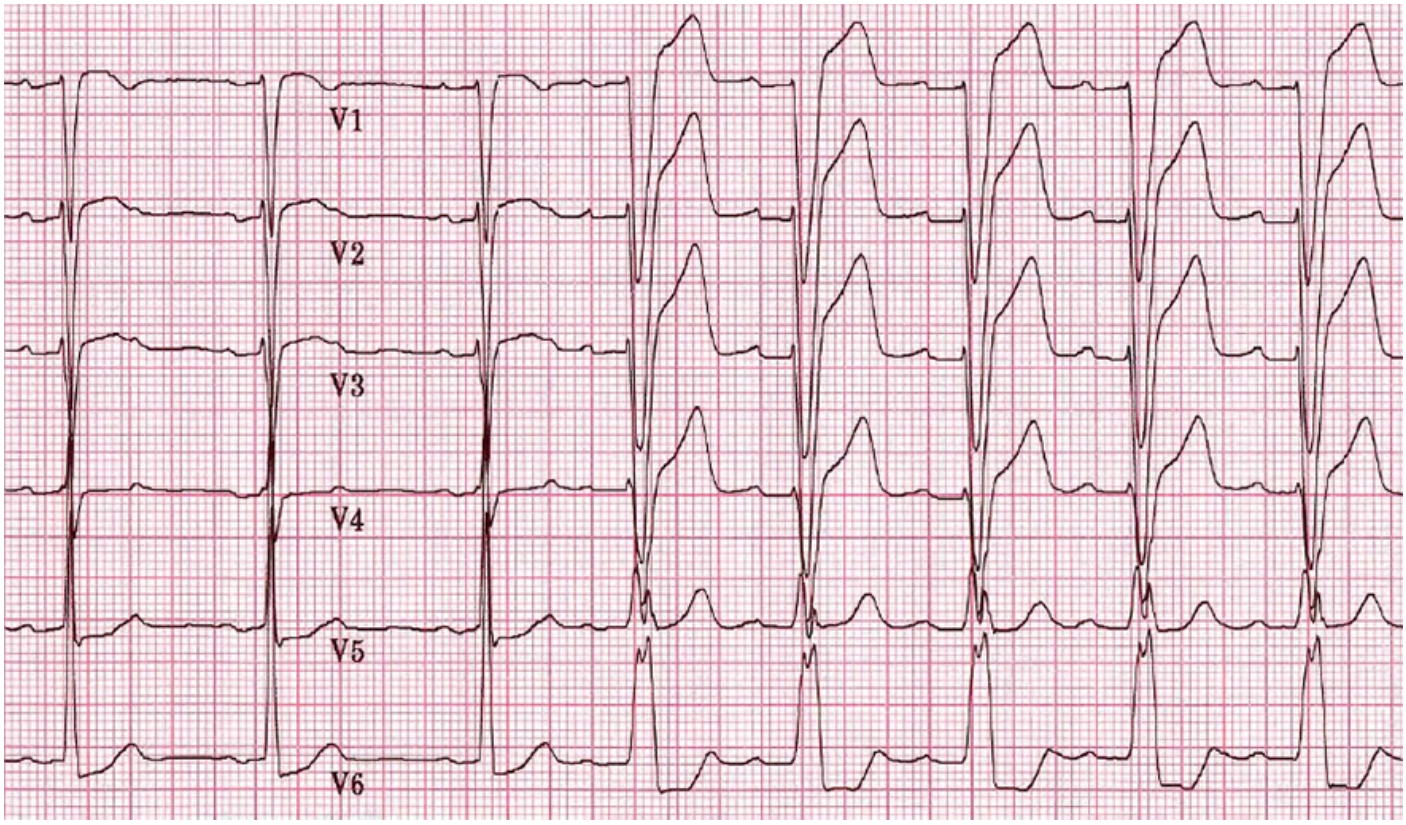

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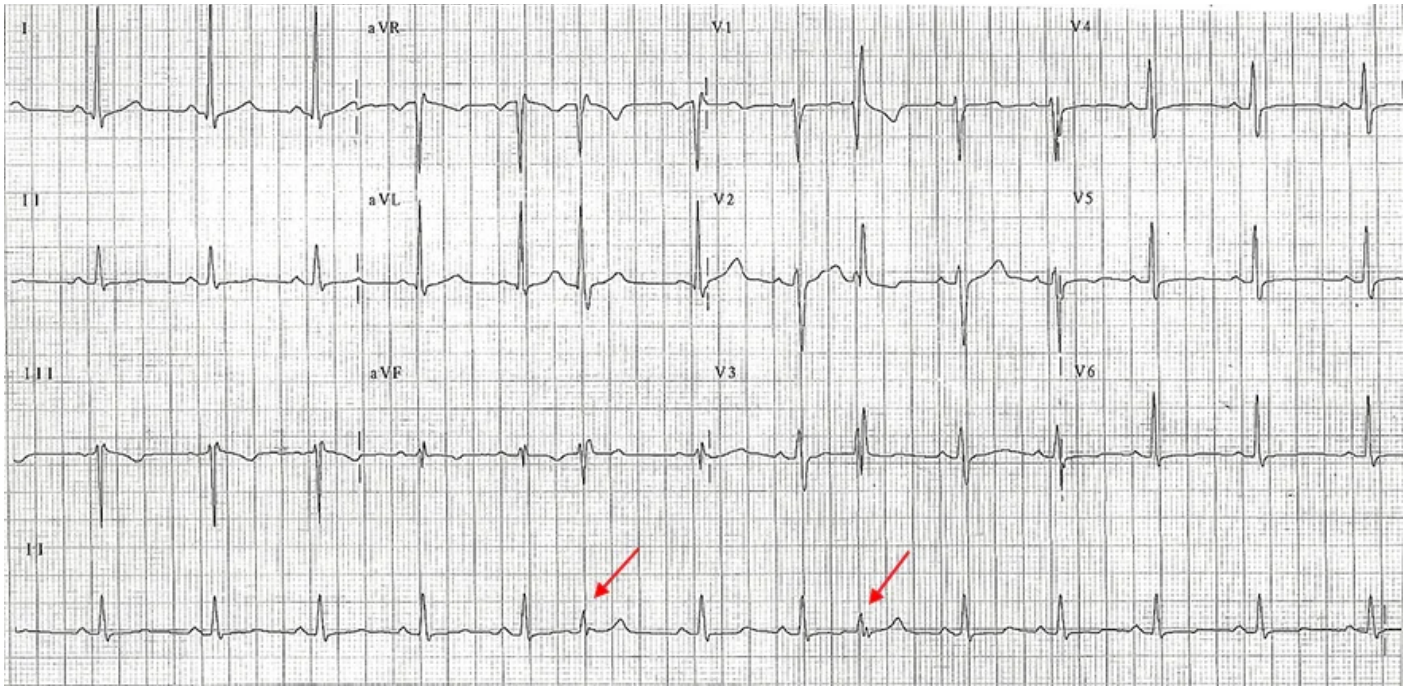
  - This indicates **damage** to the conduction system, such as in cardiomyopathy
  - The left bundle branch is more damaged in this case than the right



Aberrant Conduction and Sinus Rhythm

- Sinus rhythm
  - Heart rate: **75/min.**
- Continuous lead II (lowest)
  - The **6th and 9th QRS complexes** originated from an atrial extrasystole
    - In other leads, the QRS has the morphology of a right bundle branch block
- **Atrial extrasystoles**
  - Pass through the right bundle branch during **RRP (phase 3)**
  - Therefore, they are **blocked in the right bundle branch**, and the ventricles are activated **only through the left bundle branch**
  - This is an example of **aberrant conduction** (abnormal conduction of the impulse through the ventricular conduction system)

Sources

- ECG from Basics to Essentials Step by Step
- litfl.com
- ecgwaves.com
- metealpaslan.com
- medmastery.com
- uptodate.com
- ecgpedia.org
- wikipedia.org
- Strong Medicine
- Understanding Pacemakers